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SIX YEARS OF EXPERIMENTAL APPLE SPRAYING AT HIGHMOOR FARM

W. J. Morse

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*Died February 23, 1916

†In collaboration with U. S. Department of Agriculture.

BULLETIN 249

SIX YEARS OF EXPERIMENTAL APPLE SPRAYING AT HIGHMOOR FARM.

W. J. Morse.

Highmoor Farm was purchased by the State for the use of the Maine Agricultural Experiment Station in carrying out investigation work, more especially in connection with orcharding. Since it is located in one of the best apple producing sections of the State, conditions are favorable for this purpose. The farm came under the control of the Station in July, 1909.

The orchards at Highmoor originally consisted of about 5,000 apple trees set about 25 years previous to the time of purchase, but no data were available giving exact records as to the dates of planting. The farm had been in the hands of different owners in the meantime, and certain of these had given the trees some attention. At times they apparently received very indifferent care and at others none at all except to pick what apples were produced and to harvest the grass which was allowed to grow between the trees.

In the fall of 1909 the number of trees in the orchards proper was a little over 3,100, set 25 x 25 feet. Many of these through winter injury and neglect were in very poor condition. Later removal of those whose condition made it apparent that they were past all hope of profitable renovation reduced the number to some over 2,300, including scattering trees. Of these the greatest number were of the Ben Davis variety. Baldwins came next, followed by limited numbers of several other varieties.

The experimental spraying work has always been located in the orchard which has been designated as the Ben Davis No. 2. When the farm was purchased this orchard was by far the most thrifty of all. The trees were well headed, averaged about 20

feet in height and the trunks were about 7 inches in diameter. In the past it had evidently received more attention in the line of plowing and manuring than the others, and at one time had been used as a sheep pasture. Like all the other orchards on the farm the trees were a tangled mat of branches from lack of pruning. Beginning with 1910 this orchard, in common with all others on the farm, has been given good care in the line of pruning, fertilization, and cultivation and nothing but apples and an annual cover crop to be plowed under in early spring has been grown therein. In the fall of 1915 the trunks of the experimental trees had an average diameter of 9 inches, about 24 inches from the ground.

Nature and Extent of Experimental Work. Methods Used.

About the time the farm was purchased the value of lime and sulphur washes as fungicidal sprays for fruit trees was beginning to be recognized. On account of the very favorable results secured by Scott* with self-boiled lime-sulphur for brown rot, scab, and other peach diseases as well as for leaf-spot and bitter rot of the apple, the writer had already started a series of experiments in an orchard at Orono to test the value of this material for controlling apple scab under Maine conditions. The results for 1908 were given in Bulletin 164 of this Station, while those for 1909 were never published on account of their being rendered valueless through circumstances over which the writer had no control.

A more elaborate series of experiments were planned for the following year at Highmoor Farm, using a much larger number of trees, and a number of different kinds of sprays including cooked lime and sulphur or what is now commonly used and known as lime-sulphur. The appointment of Mr. W. W. Bonns as Station horticulturist, stationed at the farm during the summer months, led to his taking over these experiments which remained under his charge for two seasons. Since 1912 they

*Scott, W. M. A promising treatment for brown rot and other peach diseases. An address before the American Pomological Society, Sept. 1907. Self-boiled lime-sulphur mixture as a promising fungicide. Circular No. 1, Bureau of Plant Industry, U. S. D A. April, 1908.

have been carried on by the writer and his associates. The results of the season's work have been published each year in a separate bulletin. Several of these annual reports of progress are now out of print. The present publication is an attempt to present a general summary or resumé of the work done and the more important results obtained.

Object of the experiments: The primary object of these experiments centers around the efficient and economical control of apple scab with a minimum amount of injury to fruit and foliage, as applied to Maine conditions. This involves the nature of the spray used, as well as the time, number and manner of the applications.

Certain sprays, including bordeaux mixture, some of the proprietary compounds and other spray mixtures used in the course of the experiments, are very efficient in controlling scab, if applied at the proper time. This avails but little if, as has sometimes been the case, the action of the spray results in the removal of from half to two-thirds of the foliage from the tree. Also bordeaux mixture when used on the Ben Davis, although it has given excellent scab control, has invariably rendered a large part of the fruit, sometimes as high as 90 per cent, unsalable on account of russeting. Bordeaux mixture on the other hand can be used with perfect safety even on the peach in certain of the irrigated sections of the West where the summer rainfall is slight.* Lime-sulphur has been used as a summer spray without injury in the State of Washington much stronger than could be employed with safety under local conditions.† These facts and many others have shown that it is not safe to generalize too much upon or adopt without reserve results secured in other parts of the country under different climatic conditions, and emphasize the necessity of securing data based on Maine experience. Moreover, in spite of recent progress, there are numerous unsolved problems of both practical and scientific interest in connection with orchard spraying.

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*It was the writer's good fortune to visit a peach orchard in Utah in the summer of 1914 where some spraying experiments were being carried on by Dr. Geo. R. Hill which amply demonstrated this fact.

†Melander, A. L. and Beattie, R. K. The sulphur-lime wash. Pop. Bul. 28. Wash. Agl. Exp. Sta.

Extent of the experiments: As has already been indicated Ben Davis trees only have been used each year. In many respects this variety is very satisfactory for the purpose. It is quite susceptible to spray injury and would hardly be classed as particularly resistant to scab. The number of experimental trees the first season was 128 but during the last 5 years it has varied from a little less than 150 to nearly 300. The policy now followed is to use 24 trees to a plot or 4 rows of 6 trees each.

Methods used: To obtain records of results for comparison it is now the custom to reject the crop obtained on the two outside rows, or at least the outside half of these rows. This is to avoid the effects from the spray drifting across from adjoining plots which received different treatments. At harvest time the entire crop from the portion of the plot so selected, or 20 barrels of it selected at random if the crop amounts to more than this, is carefully sorted and examined. The total number of fruits, the number of scabby and russeted and the percentages of the latter, as well as the percentage of perfect apples are determined and recorded. During the summer observations are made at frequent intervals and a careful record made of the effects of the different sprays on the foliage.

As far as possible all plots receiving the same number of applications are sprayed on the same day. Very little trouble has been experienced with scale or blister mite so dormant sprays have been used only in exceptional cases and for special plots as will be described later. In other words, the present discussion is almost wholly limited to the action of sprays applied to trees in leaf for the control of apple scab. Dormant sprays are only considered in connection with their possible effects in controlling the scab fungus and in the production of spray injury.

Unless certain applications were omitted for a definite purpose on individual plots, 3 applications have been made—the first when the fruit buds were showing pink, the second just after the petals fell and the third between two and 3 weeks later. On account of seasonal conditions the date of the first application has varied considerably. The earliest was May 8, 1913, and the latest were May 23, 1914, and May 24, 1912. The second date has been more constant, the limits being from May 30 to June 7, and in 4 out of 6 seasons from June 3 to 6. The

number of days which elapsed between the first and second applications were as follows: 25 in 1910, 18 in 1911, 12 in 1912, 26 in 1913, 14 in 1914, and 20 in 1915.

In all cases arsenate of lead has been added as an insecticide to the various, so-called fungicidal sprays at the rate of two pounds of paste or one pound of dry powder to each 50 gallons. This amount has always proven sufficient for the control of chewing insects. The powder has been used exclusively in the more recent experiments. At first a plot sprayed with this amount of poison in water alone was used as a check. After the marked fungicidal effects of arsenate of lead were noticed a check plot was reserved which received no spray whatever.

In Mr. Bonns first experiment in 1910 a hand-pump, barrel outfit was used, while in 1911 his applications were all made with a Niagara carbonic acid gas sprayer. Since that time a large gasolene power sprayer, carrying two leads of hose, has been used exclusively. After each plot receiving a different treatment was sprayed the entire apparatus, including tank, pump, hose, extension rods and nozzles was thoroughly washed and flushed with clean water. Throughout the work nozzles of a type which deliver a fine mist have been employed, and the sprays applied with a pressure varying from 150 to 200 pounds. The person in charge remained in the field in constant supervision of the spraying crew while the applications were being made, care being taken to see that all of the foliage on each tree was reached as nearly as possible without applying sufficient spray to cause excessive dripping.

Detailed Discussion of Combined Results.

Bordeaux mixture vs. lime-sulphur: Each season during the 6 years plots have been sprayed with bordeaux mixture and standard dilution lime-sulphur prepared from a concentrate made on the farm.* For this purpose during the last 4 years a 3-3-50 bordeaux mixture has been used exclusively. Except in the earlier work before the relative merits of the two fungi-

*Standard dilution lime-sulphur as used in this publication signifies the equivalent of a 1 to 40 dilution of a 33° B. concentrate, or 1.22 gallons of a concentrate having this test diluted to 50 gallons with water.

cides had been fully determined these plots have been introduced solely for the purpose of checks to serve, together with the unsprayed plot, as a basis of comparison with other sprays and spray combinations with respect to scab control and the production of fruit russeting and foliage injury. They have, however, given some very striking data as to the comparative value of the two materials when used on a variety of apples which is particularly susceptible to spray injury.

Lime-sulphur at the dilution mentioned has sometimes given a little leaf injury but never sufficient to be of economic importance. When compared with the unsprayed check plot this treatment has increased the number of russeted apples from 5 to 10 per cent during the past 3 seasons. Scab control has been less than with bordeaux mixture but the greatest difference has been only about 3 per cent.

Bordeaux mixture on the other hand has caused serious leaf injury nearly every year for the past 6 seasons, frequently resulting in partial defoliation of the trees. Its greater efficiency in scab control has been discounted several times over by the increased fruit russeting produced. In the past 3 years the per cents of merchantable apples on the plot sprayed with bordeaux mixture have been in round numbers, 30, 10, and 21, respectively. At the same time the unsprayed check, not even treated with an insecticide, gave 30, 87, and 91 per cent of the same grade of fruit. In other words, based on the quality of the fruit produced, nothing was gained the first year and heavy losses resulted the next two years from spraying Ben Davis trees with 3-3-50 bordeaux mixture.

The effect of different dilutions of lime-sulphur: The question of the effect of different dilutions of lime-sulphur in controlling scab and in the production of spray injury was one of the first problems to be studied. A spray containing 25 per cent less concentrate than the standard dilution was tried for two years, in but one of which was scab very prevalent. That year the plot treated with the weaker spray produced 13 per cent more scabby fruit than was obtained where the standard dilution was used. The matter was not followed farther for it was evident that this weaker dilution would prove inefficient.

A comparison between standard dilution lime-sulphur and one 20 per cent stronger was carried on for 4 consecutive seasons.

Practically no scab developed even on the check plots the first year but during the last 3 years there was an average increase of 8 per cent of merchantable apples as the result of using the stronger spray. The greatest increase in any one year was 21 per cent in 1912. That season, however, through a misunderstanding in the writer's absence, the first spray application on both plots was omitted. While the conditions of the test were equally severe in both cases it is possible that if the applications had been made when the fruit buds were showing pink the differences between the two plots would not have been so great. As will be shown later this first application was a very important one that season.

Only one season was increased foliage injury noted where the stronger spray was used and this was slight. Contrary to expectation there was, two years out of 3, more russeting of the fruit where the weaker spray was used. These differences, however, averaged less than 3 per cent.

From the work of the 3 seasons it would seem that on the Ben Davis, a variety easily injured by bordeaux mixture, a dilution of lime-sulphur at least 20 per cent stronger than the commonly recommended may be used with comparative safety. Also in some seasons, at least, the greater efficiency in scab control secured will more than cover the added cost of materials.

The importance of the blossom bud application: Certain students of the subject of apple scab control have laid much stress upon the importance of the spray application made when the fruit buds are showing pink. Present knowledge of the life history of the apple scab fungus and some experimental data obtained in Maine tend to confirm these conclusions derived from work done elsewhere. However the results secured at Highmoor during 4 consecutive seasons indicate that under Maine conditions it is not necessarily a foregone conclusion that the spraying operations for the current year are doomed to utter failure if no spray is applied till after the petals fall.

Two seasons out of the 4, omitting the blossom bud application of lime-sulphur entirely actually resulted in a higher percentage of merchantable apples. Another season the increased efficiency due to the first application was of little account. The differences for all 3 seasons were slight, however, and were doubtless within the limits of experimental error. Therefore

omission of the first spray 3 years out of 4 led to no material difference in the results. On the other hand a like omission the first year the experiment was tried meant, from the standpoint of the practical orchardist, a difference between success and failure in the spraying operations of the year. Where all 3 applications were made nearly 90 per cent of the fruit was sound and perfect. Only about 50 per cent of the same grade of fruit was obtained where the first application was omitted. This was in 1912, a season particularly favorable for scab development. The date of the first application that year, May 24, was with one exception the latest since the series of experiments were begun.

Arsenate of lead as a fungicide: The apparent high fungicidal value which this well-known insecticide has shown is one of the quite unexpected results obtained.

The first suggestion of the value of arsenate of lead for controlling apple scab, as shown by these experiments, came in 1912. Then 4 pounds of the paste arsenate of lead alone in 50 gallons of water gave as good or better scab control than did a 3-3-50 bordeaux mixture or lime-sulphur plus two pounds of the paste in each 50 gallons of spray. Unfortunately no check plot was saved that season, but over 3 times as much scabby fruit was obtained on a plot sprayed with two pounds of the arsenate of lead paste in 50 gallons of water than were produced where double this amount of the insecticide was used alone. One possible explanation for the apparent fungicidal action of the larger amount of the poison that season was that the plot on which it was used was located at the corner of the orchard more exposed to air and sun. This factor was eliminated in the later experiments.

In all later work an unsprayed check plot was added and dry arsenate of lead substituted for the paste form. In 1913 one plot was sprayed at all 3 applications with two pounds and another plot with one pound of the dry, powdered insecticide in 50 gallons of water. Nearly 39 per cent of the apples on the unsprayed plot were scabby. Almost perfect scab control was obtained with bordeaux mixture, the larger amount of the arsenate of lead used alone, and lime-sulphur 20 per cent stronger than standard dilution—the efficiency being in the order named. Somewhat poorer results were obtained with standard dilution lime-

sulphur. Attention is again called to the fact that one pound of the dry arsenate was added to each 50 gallons of the bordeaux mixture and lime-sulphur used. This smaller amount of the insecticide when used alone in 1913 reduced the amount of scab, as compared with the unsprayed check from 39 to less than 16 per cent.

A large amount of fruit russeting was experienced in the experimental orchards in 1913, apparently due to natural causes, but this was materially increased by the action of some of the sprays. With bordeaux mixture and lime-sulphur the per cents of russeted apples showed an increase of 38 and 11 resectively over that recorded for the unsprayed check, while russeting on the plot sprayed with the larger amount of arsenate of lead alone was even less than on the check. On account of the last mentioned fact the relative value of the arsenate of lead spray was still more apparent that season. About 12 per cent more perfect apples were obtained with it than where standard dilution lime-sulphur was used.

Neither in 1914 nor in 1915 did scab develop sufficiently to give a rigorous test of the fungicidal properties of arsenate of lead. In scab control in 1914 two pounds of dry arsenate of lead in 50 gallons of water fell about 3 per cent behind standard dilution lime-sulphur containing one-half of this amount of the insecticide, but on account of freedom from russeting with the former the per cents of merchantable apples were practically the same. In 1915 the combined lime-sulphur and arsenate of lead gave a fraction of one per cent better scab control, but on account of russeting, only about 90 per cent of the apples were merchantable. In contrast with this, because of freedom from russeting, the larger amount of arsenate of lead used alone gave over 97 per cent of the same grade of fruit.

Strong fungicides for the first application followed by arsenate of lead alone: The aparent high efficiency of arsenate in apple scab control, as indicated by the above described experiments, suggested the following possible modification of summer spraying practice. Use a strong fungicide combined with a smaller amount of arsenate of lead when the fruit buds are showing pink. For all later applications depend entirely on arsenate of lead for the control of both scab and chewing insects, using at least two pounds of the powder or 4 pounds of the paste

to each 50 gallons of water. This program has been followed experimentally for two seasons. For the first application 3-3-50 bordeaux mixture and lime-sulphur 20 per cent stronger than standard dilution have been used.

The crop in each case has been very free from scab but on account of the fact that the omission of the first application of standard dilution lime-sulphur on other plots during the same seasons failed to show an increase of scab it is impossible to draw definite conclusions regarding the chief object in view. However all evidence obtained tends to confirm the results secured where arsenate of lead was used alone during these and previous years.

One important conclusion has been reached. It is evident that bordeaux mixture cannot be used at Highmoor on the Ben Davis, even for the first application when the leaves are beginning to unfold and the blossom buds are not yet open. With it, used in this way, more or less leaf injury has been obtained each season. What seems harder to explain is that a single application of bordeaux mixture, made before the fruit buds opened has led to a considerable increase in the russeting of the fruit formed considerably later. This increase in russeting amounted to nearly 15 per cent in 1914, and about 9 per cent in 1915. In 1914 this plot adjoined one sprayed 3 times with bordeaux mixture and it was thought that the increase in russeting might possibly be the result of the spray drifting across from the latter. A relocation of the plots in 1915 prevented such a possibility.

No such difficulties were experienced where lime-sulphur, 20 per cent stronger than standard dilution, was used for the first foliage spray, but as will be mentioned later an application of dormant strength lime-sulphur somewhat earlier, but after the leaf buds had begun to open did produce similar effects in a marked degree.

Dormant sprays for insects as affecting scab control: Certain observations made in another orchard in a different part of the State, during the summer of 1913, showed quite conclusively that where young McIntosh apple trees having an abundance of limb infection with apple scab from the season before were sprayed with a dormant strength lime-sulphur solution just as the leaf buds were opening, in addition to the regular

summer sprays, the amount of scab appearing on the leaves the following summer was materially decreased.* Lowe and Parrott working with the control of San Jose scale by means of the lime-sulphur-salt wash in 1902 in New York recorded a reduction in the amount of scab following a single late application of this spray.† The Baldwin variety of apples was used. No mention is made of limb infection by scab, but the following significant statement is made with regard to the control of the disease on the fruit during the season following. "Of special interest in this connection also is the fact that although the trees received no treatment except with the lime-sulphur-salt wash, the fruit from the treated trees was practically free from scab, while that of the checks was badly infested." The single spray application was made late in April and was very thoroughly done. "In many cases the buds had already burst and in some cases the leaves were well out, while in others only the tips of the young leaves were beginning to appear." It may be mentioned also that many of these young leaves were badly burned by the treatment. These injurious effects were temporary, simply tending to delay the appearance of the foliage somewhat. In a short time it "was as abundant and vigorous as in any of the neighboring orchards."

No cases of limb infection with apple scab have been observed on the Ben Davis at Highmoor but the question is frequently raised by orchardists as to whether it is safe or advisable to apply a dormant spray of lime-sulphur after the leaf buds have begun to unfold and the flower buds are swelling. To secure data upon this point and upon the question of scab control, a single plot received a late application of dormant strength lime-sulphur, in addition to the regular spraying with the summer dilution of the same material combined with the usual amount of arsenate of lead.

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*Morse, W. J. and Darrow, W. H. Is apple scab on young shoots a source of spring infection? Phytopahtology 3:265-269. Oct., 1913. Morse, W. J. Spraying experiments and apple diseases in 1913. Bul. Me. Agr. Exp. Sta. 223:20-23, Jan., 1914.

†Lowe, V. H., and Parrott, P. J. San Jose scale investigations. IV. Bul. N. Y. Agr. Exp. Sta. 228:295-297. 1902. (Reprinted in 21st Annual Report of the N. Y. Agr. Exp. Sta. with the same paging, 1903).

At the time of the application of the dormant strength lime-sulphur, May 8, the blossom buds appeared well protected. The young leaves surrounding them were not over one-third inch long, frequently less, and closely imbricated. Considerable burning of the leaves was experienced and some of the flower buds were injured, in the case of a few clusters all except the central bud or buds being killed outright. These effects soon passed away, the foliage later appearing fully as vigorous and abundant as that on the trees of the surrounding plots and as far as could be determined the total yield of apples was not lessened. The amount of scab on the fruit was slightly less than that on the plot treated exactly the same with the exception that the late dormant spray was omitted, but the differences obtained were plainly within the limits of experimental error.

A much more significant result is the amount of russeting of the fruit as shown by the records obtained at harvest time. The unsprayed check plot produced approximately 3.6 per cent of russeted apples, the one sprayed with 3 applications of summer dilution lime-sulphur gave a little less than 10.5 per cent, while the amount of russeting was increased to nearly 22 per cent where the late dormant spray was used in addition. Here again, as in the case of bordeaux mixture already mentioned, the application of a strong fungicidal spray before the blossoms were open (in this case before the flower buds had enlarged materially) and long before the fruit had set was followed by a marked increase in the russeting of the latter. However, as has already been stated no such marked increases have been experienced when the strength of the standard summer dilution of lime-sulphur was increased by adding 20 per cent more of the concentrate.

Self-boiled lime-sulphur: Interest in this material in connection with apple orchard spraying is largely historical. Although experience has shown that it is too weak a fungicide to be profitably employed in Maine for the control of apple scab, the results secured with it in other parts of the country in treating diseases of the peach and the plum without injuring the more tender foliage of this class of fruit trees, and even for treating certain apple diseases, led to the immediate development of the stronger and more effective lime-sulphur made by

mixing together definite quantities of lime, sulphur and water and then boiling for some time with artificial heat.

Mention has already been made of the earlier experiments of the writer with this material at Orono. There self-boiled lime-sulphur made with hot water was more effective in scab control than that made with cold water where the slaking lime provided the only source of heat to bring about chemical action between the lime and the sulphur. Much better results were secured with bordeaux mixture.

Self-boiled lime-sulphur, also made with hot water, was used at Highmoor but one season, or in the first series of experiments. With it Mr. Bonns secured a reduction in the amount of scab on the fruit from 41.75 per cent to 15.40 per cent as compared with the check. That season however it gave nearly as good scab control as did bordeaux mixture and home-cooked lime-sulphur, but was considerably less efficient than dilutions made from certain commercial brands of lime-sulphur concentrate.

Copper-lime-sulphur: Dr. Howard S. Reed and his associates in Virginia reported very satisfactory results in spraying apple trees for rust, with lime-sulphur to which two pounds of copper sulphate dissolved in water were added to each 50 gallons of dilute lime-sulphur spray. They stated that this spray was not injurious to the foliage.* In a later publication additional data is given including the following statement. "On most trees, when copper-lime-sulphur was used, it was possible to find leaves whose margins were much darker green than the normal leaves, but no evidence of scorching by this material was found."† The York Imperial is mentioned as the variety of apples used.

At Highmoor in 1914 a plot of Ben Davis was sprayed with this copper-lime-sulphur mixture to which the usual amount of dry arsenate of lead had been added. As far as scab control was concerned the results were practically identical with

*Reed, Howard S., Cooley, J. S. and Crabill, C. H. Experiments on the control of the cedar rust of apples. Bul. Va. Agr. Exp. Sta. 203. Jan., 1914.

†Reed, Howard S. and Crabill, C. H. The cedar rust disease of apples caused by *Gymnosporangium juniperi-virginianae* Schw. Tech. Bul. Va. Agr. Exp. Sta. 9:87. May, 1915.

those secured from the same dilution of lime-sulphur without the addition of copper sulphate. On the other hand where the lime-sulphur was used alone no foliage injury was observed and only about 4.5 per cent of the fruit was russeted. On the copper-lime-sulphur plot severe foliage injury occurred, closely resembling that produced by bordeaux mixture and nearly equal to the amount obtained with "Soluble sulphur." At harvest time over 57.5 per cent of the fruit was unmerchantable on account of russeting.

This experience with copper-lime-sulphur farther emphasizes the fact that in apple spraying the results secured in other parts of the country using different varieties, grown in a different climate, may or may not be applicable to local conditions.

Extra fine sulphur flour as a fungicide for scab: A suspension of finely ground sulphur in water at the rate of 10 pounds in 50 gallons was used as a spray on one plot in 1914 and again in 1915.* While scab did not develop sufficiently in the orchards either season to make the test a severe one it is evident from the results that this form of sulphur, used in the manner described, has considerable fungicidal value. As compared with the check the per cent of scabby apples was reduced from about 12.5 per cent to a little over 3 per cent in 1914. In 1915 these figures were 5 per cent and a little over one-half per cent respectively.

The fungicidal properties of very finely ground sulphur have recently been well demonstrated by the pathologists of the Cornell University Agricultural Experiment Station by means of numerous and extensive experiments in dusting apple trees and various kinds of nursery stock with it mixed with powdered arsenate of lead, also in dusting hops for mildew with sulphur alone.

There seems to be no particular advantage in using the watery suspension of sulphur as employed experimentally at Highmoor. Dusting on the other hand is claimed to have decided advantages, particularly for very high trees and for rough or hilly orchards as the lighter dusting machines can be taken where it would be impossible to go with the heavier spraying

*The method for making this suspension is described on page 180 of Bulletin 240 of this Station.

apparatus. It is also of advantage in orchards which are remote from an adequate water supply.

Proprietary spraying compounds: Under this heading only those spraying materials are considered which have been tried in comparison with lime-sulphur and bordeaux mixture—the commercial brands of lime-sulphur concentrates are not discussed.

The first material of this kind employed was what is known to the trade as "Sulfocide" and was used by Mr. Bonns in 1910. For the first two applications one-third gallon was used to 50 gallons of water with two pounds of arsenate of lead paste added. For the third and last application the amount of "Sulfocide" was decreased to three-sixteenths gallon and the amount of arsenate of lead paste increased to 3 pounds.

Very serious injury followed its use. Leaf scorching of the most severe type followed shortly after the second application. This injury was increased by the final application although the amount used was a greater dilution than the weakest strength recommended by the manufacturers. The fruit was also injured severely, particularly around the calyx. As a result nearly 45 per cent of the apples at harvest time were found to be so badly deformed and injured as to render them unsalable. "Sulfocide" proved very efficient in scab control, but on account of the injury mentioned the amount of merchantable apple secured with it was far less than where no spray at all was applied.

A dry powder to be applied after dissolving and diluting with water and known under the trade name of "Soluble sulphur" was used in 1913 and 1914. This has been much advertised and sold in Maine as a substitute for lime-sulphur. The manufacturers did not make such claims but many orchardists purchased and used the material supposing that it was identical in composition with lime-sulphur, except that the water in the liquid had been removed.

The first year at Highmoor two pounds of this powder and one pound of dry arsenate of lead was used in 50 gallons of water. Efficient scab control was secured but the effects on the foliage were disastrous. Shortly after the second application of the spray very evident leaf injury began to appear in the form of spotting and more or less browning of the margins. This injury developed slowly till after the third application on

June 24. After that it progressed quite rapidly so that by July 7 from 75 to 90 per cent of the leaves were affected, with much yellowing and leaf drop showing at this time. On July 15 the ground was nearly covered with fallen leaves, and the appearance of the trees showed a marked contrast with those on adjoining plots, sprayed with other materials, which were covered with healthy foliage.

The experiment was repeated the second year, reducing the amount of the fungicide to three-fourths pound in 50 gallons. The effects on the foliage were essentially the same as before. No injurious effects were observed on the fruit. The results of two successive trials indicate that even when used in small quantities "Soluble sulphur" is an efficient fungicide for scab, but at the dilutions tested it is unsafe for use as a summer spray for apple foliage. Reports secured from several Maine orchardists who used the material as a summer spray in 1913 fully confirmed this conclusion. No attempt was made to test its merits as a dormant spray.

Another proprietary compound used is known as "Atomic sulphur." This is sold in the form of a paste. It was used two seasons at the rate of 7 pounds, plus the usual amount of arsenate of lead, diluted with 50 gallons of water.* No injury to fruit or foliage was obtained. Scab control on the fruit and the percentage of perfect apples was very nearly the same as was secured with standard dilution lime-sulphur both seasons.

*Through error due to following the directions of a local dealer 14 pounds of "Atomic sulphur" to 50 gallons was used for the first application the first season.